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SUBMINIATURE TUBES AND SMALL BATTERIES USED IN HEARING AIDS

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Electrical hearing aids can be divided into tubeless (microtelephonic) and vacuum-tube aids.

A. Microtelephonic Hearing Aids

The simplest microtelephonic hearing aid consists of a carbon microphone, a low-voltage battery, frequently from a flashlight, an electromagnetic telephone, a rheostat (volume regulator), and a switch, all connected in series.

The microphone usually has two carbon blocks; instead of powder, carbon spheres 0.8 millimeter in diameter are used. The sensitivity of this type of microphone is very high and reaches 300 millivolts per bar in the region of highest sensitivity for a DC component through the microphone of about 35 milliamps and static resistance of the microphone of about 100 ohms.

The telephone also has high sensitivity, reaching 2,000 bars per volt for an active resistance of about 10 ohms. The maximum amplification constant with respect to sound pressure which can be reached by a simple microtelephone hearing aid is about 12 (amplification constant equals sound pressure developed by telephone divided by pressure at the microphone).

This amplification is not enough for most deaf people, and therefore the so-called microtelephonic amplifier has been used since about 1930 in hearing aids of this type. The maximum amplification constant of a microtelephonic amplifier, which is the second stage of amplification in the hearing aid, is about 10-12 (20-22 decibels).

The circuit of a hearing aid with a microtelephonic amplifier is shown in Figure 2. /Figures referred to are appended/. The total current drawn by this aid is about 80 milliamps and the maximum amplification constant with respect to sound pressure reaches, within a quite limited frequency band, 100 (40 decibels). The complete frequency response of the microtelephonic aid as compared with the vacuum-tube aid is shown in Figure 4.

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The main defect of microtelephonic hearing aids is that they reproduce sounds with considerable frequency and nonlinear distortions. Nonlinearity of the carbon capsule (in both the microphone and amplifier) is most unfavorable because it reduces the amplification constant for weak sounds. This limits the distance from the source at which the microtelephonic hearing aid can be used to 2 to 4 meters.

B. Vacuum-Tube Hearing Aids

The vacuum-tube hearing aid consists of four main elements: the microphone, amplifier, telephone, and filament and plate batteries.

The small, light microphone, which is usually piezoelectric, has comparatively high sensitivity, up to 30 millivolts per bar. This microphone is most sensitive between 3,000 and 4,000 cycles.

Vacuum-tube hearing aids have two or three stages of amplification using subminiature pentodes. A 30-45 volt plate battery is sufficient for normal operation of these tubes. The 06P2B and 1P2B subminiature tubes are produced especially for hearing aids. The first of these, the 06P2B, draws only 30 milliamps filament current at 0.63 volts; the second, the 1P2B, draws 50 milliamps at 1.25 volts. These tubes are shown in Figure 5. The A battery for these tubes employs "Saturn"-type cells, while the B battery is a special miniature pressed plates (galetnaya) battery.

The vacuum-tube aid can also be supplied from the lighting circuit through a rectifier, which is naturally a component of an aid employing tubes in which AC can be used on the filaments, e.g., the 955 acorn tube or the 6J6 twin triode. A wiring diagram of this type of hearing aid is given in Figure 7.

If a two-stage amplifier is used, the first stage is transformer- or choke-coupled to obtain high amplification. If the amplifier has three stages, the first two are resistance-coupled. The load on the output stage, i.e., the ordinary or bone telephone, is connected through the output transformer. The output transformer is required because the telephones, owing to their small size, cannot be made high-resistance for direct connection into the plate circuit of the output tube. The amplifier has a volume regulator, a tone regulator, and a filament switch; the latter is usually assembled on the same knob as the volume or tone regulator.

The tone regulator frequently changes only reproduction of the lower frequencies. This can be done by changing the value of the resistance shunting the microphone. In three-stage amplifiers, where total amplification is not the primary concern, negative feedback is used.

The maximum amplification constant with respect to intensity of a two-tube amplifier is about 60 decibels, and of a three-tube amplifier, about 72 decibels. The maximum amplification constant of a three-tube hearing aid with respect to sound pressure is about 52 decibels.

Figure 9 shows the wiring diagram of a battery-powered three-tube aid of the LAB-8 type, which is produced by Moscow Hearing Aid Plant. This aid permits speech to be heard at distances of 6 to 10 meters.

The high acoustic properties of vacuum-tube hearing aids have increased the number of deaf people who can be helped by hearing aids by 15-20 percent.

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NOTE

Figures 1, 3 and 6, and 8 in the text are omitted. Figure 1 shows the construction of a microtelephonic amplifier. Figure 3 gives an over-all view of a microtelephonic hearing aid. Figure 6 shows an over-all view of a vacuum-tube hearing aid. In Figure 3, the battery shown is about twice the size of a small matchbox and the case carries Hearing Aid Plant Rating Plate #2708. In Figure 6, the plate battery is roughly double the size of a small matchbox, while the filament battery is about 2/3 the size of the plate battery. The following can be read on the filament battery: Galvanic Cell for Hearing Aids KS-SA EMF-1.6 /illegible/ volts; Capacity - 2.5 ampere-hours /illegible/, and on the plate battery: Battery-Plate, Dry, for Hearing Aids GB-SA-45 (No 160-32); EMF-48 volts; Capacity 0.2 ampere-hour. Figure 8 shows the construction of an LAB-8-type battery-powered three-tube aid.

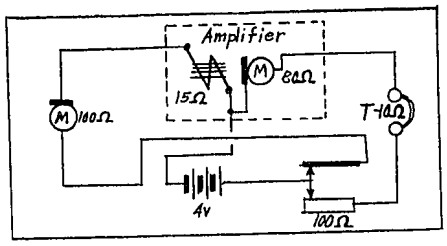

Figure 2

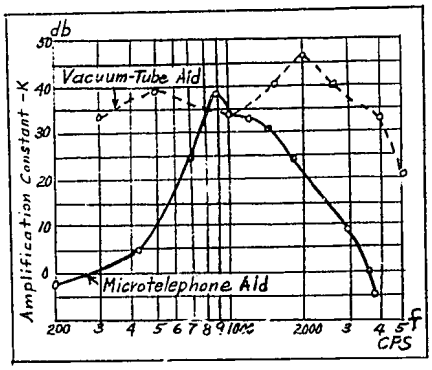

Figure 4

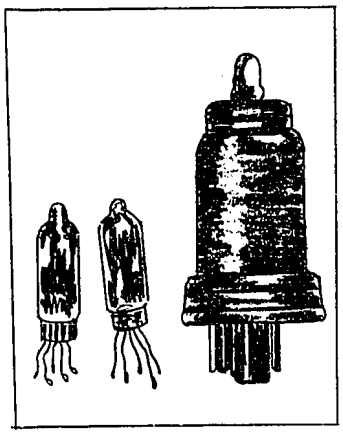

Figure 5

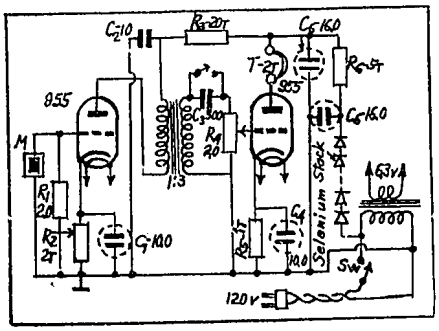

Figure 7

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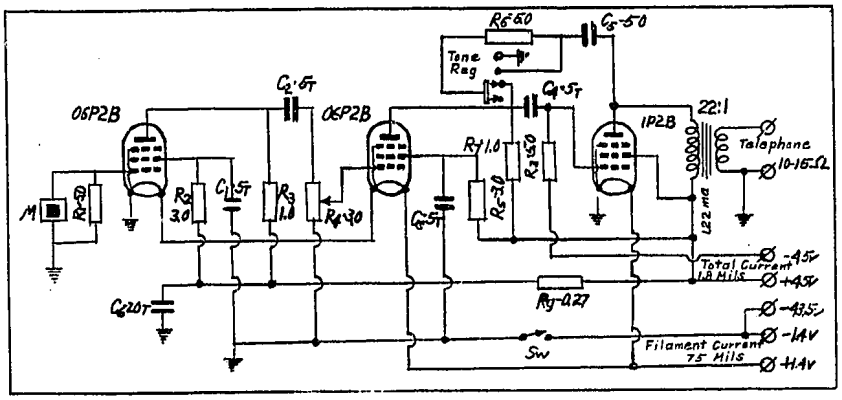

Figure 9

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